The Heart as an Ocean
exploring meaningful interaction with biofeedback

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Abstract. This paper discusses the need to redefine the concept of 'interaction' within the context of interactive (audio) installations. This discussion is based on the realization of **'**The Heart as an Ocean', a media piece that explores the relationship between auditory senses and biometric feedback.

1. Interactivity in the context of arts

'The Heart as an Ocean' is a new media piece (designed by the first author) that is based on the artistic use of the participant's auditory senses and biometric feedback. In a broader context, 'The heart as an Ocean' also functions as an experimental setting in which new forms of interactivity are explored , more particularly in the context of media installations and new technologies. The media piece explores the fundamentals of meaningful interaction by looking to what extend the physiology of the body can be both sensor and actuator in an art context. The installation was first exhibited at Gallery Jan Colle in Ghent, Belgium[i] in February 2007.

Figure 1: Gallery Jan Colle, Belgium.

2. Problem definition

Within the arts, interactive media installations become more and more prominent, although interactive media installations are seldom part of the permanent collection of museums. Interactive media installations have been mostly exhibited at special festivals like the Ars Electronica festival in Austria or SIGGRAPH in the U.S. Recently some private organizations, started to build collections of media installations (in Belgium, see the Verbeke Foundation[ii]). Although they are oriented towards a more general public rather than a public of specialists, it still requires a specialised exhibition environment and some advanced maintainability of the installations.

2.1. Interface and Usability

The usability and user interaction are among the most defining factors when developing interactive media installations for art. When dealing with usability it is important to take into account that technical complexity of both the user- interface and the sensory data mapping which mainly influences the experience. On the one hand the complexity can be due to the fact that the user interface is too complex or on the other hand that reactions of the system having little to none of an obvious correlation with the public's interaction. Until now this resulted into a way of thinking about 'interactivity', usability and interface design as a subtle equilibrium between the need of easy-to-use interfaces and a certain amount of complexity. This should result in an exciting experience where people are challenged to explore and play with the installation. Although this may be sufficient to explore some technical issues surrounding new media installations it seems not sufficient enough to explore a more conceptualised meaningful interaction.

2.2. Meaningful interaction

In the design of 'The Heart as an Ocean', art has been conceived as a way to communicate between artist and public, but also to communicate on a broader social level among the public itself. Art communicates ideas through sense and the artistic experience is a result of the effectiveness of this communication. It involves a conversation between artist and art piece, and between art piece and public. Within an ideal interaction this relation is symbiotic both in concept as in realisation. There is a need to differentiate between responsiveness and interaction eventhough both may have its distinct use in digital arts and entertainment.

The responsiveness of interactive art can be situated between a range of 100% responsive and 100% autonomous. From that perspective, hyperinstruments[iii] for example, are 100% responsive since they always respond in the same manner to the same stimuli. However in using hyperinstruments in interactive installations, the public is often confronted with a learning curve during which technical possibilities and functions of the device have to be explored and learned. Of course this may be fun and exciting in itself. Yet, in the end this focus on the instrument may result in a rather limited experience of interaction, since the interaction does not necessarily imply a goal-direction. Therefore no effect of non-mediation or implicit conceptual meaning can be developed. As a result, the artist may have the feeling that the public is not able to transcend beyond the barrier

of the technological mediator, and the public may have the feeling that it never experienced the artist's intentions.
The question is whether it is possible to cope with this problem of technological mediation and learning curves. Are there ways to overcome the inherent limitations of hyperinstruments?

3. Basic concept

In 'The Heart as an Ocean', the goal was to get a natural flow of communication without the restrictions of having a too technical interface that could obtrude the intended interaction. The interaction had to work like an affordance. No sophisticated explanations should be necessary to interact, and user feedback should be based on a very strong homogeneity in 'experiencing'.

3.1. In depth concept

The media piece was designed in such a way that the state of mind of any person who interacts with the installation could be sensed. This way it would be possible to influence that person's physiology through sound in such a way that the outcome would be similar for every participant.
To achieve this goal, a synthesised ocean wave was created, that imitated the breaking of a wave on an imaginary shore. The intensity, level, duration and amplitude of the wave are all derived from the heart rate of the person who interacts with the installation. The way in which the musical parameters relate to heart rate is as follows: an agitated person, with a strong and fast heart rate, would generate strong loud and fast waves. A calm person, with a weak and slow heart rate, would generate slow and gentle waves. Since a new wave is generated at every heartbeat the auditory illusion of a sea breaking on a shore is created. This effect is emphasised by a spatial movement of each wave in a setup with eight speakers. Each wave starts its cycle randomly at one position and moves through the auditory space using the other speakers. The sound of the sea was initially chosen because of its soothing effect. Secondly, water has played an important role in the spiritual, psychological and physical ablution throughout history. Moreover, the sound of the sea has all frequency bands in it and therefore, it can be conceived as a sort of a white noise signal spread out in space. Because of this, it largely numbers out all other surrounding sounds resulting in a very personal auditory space. Michael Wenger, Dean of Buddhist Studies at the San Francisco Zen Centre[iv], speaks about this:

"Moving water is 'white noise,' in which you can hear many things. Each individual may hear a different song in the water. Just listening to the sound--not tying it to anything, just letting sound wash over you--is a way of letting go of your ideas and directly experiencing things as they are."

4. Technical realisation

When the installation was first presented there were some difficulties related to the use of the heart rate sensor, which had to be taken into consideration while programming the software. During a recent upgrade of the project, the heart rate sensor has been replaced with a wireless sensor. This gives better results and leads to a less obtrusive interaction.

4.1. Hardware

'The Heart as an Ocean' consisted of seven satellite speakers, one subwoofers and a heart rate sensor hooked up to an Arduino[v] board connected to a Mac Book. The seven satellite speakers were spread across a wall spanning eight meters. The subwoofer was discretely placed in the room. An M-Audio Firewire audiophile was used in conjunction with the computer line output to create an aggregated device providing eight line level outputs. An extra nineteen-inch screen showed the software GUI. The speakers were hidden in order to emphasize the atmosphere of the exhibition space, giving more room to the audio.

4.2. Software.

The software is developed using Cycling 74's MAX/MSP[vi]. On the top level there is a GUI running, which enables a real-time HD recording of the interaction. This can be rendered to a DVD and is offered as a multiple.

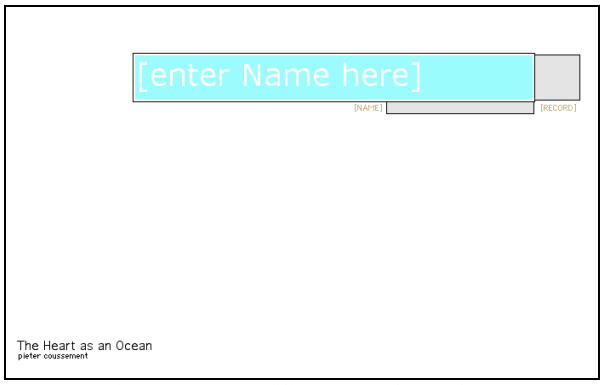

Figure 2: GUI enabling a named recording.

Beneath the GUI level there are several patches working together to capture and calculate the heart rate from the sensor, to create the waves, to take care of the spatial position of the wave and to render the recordings.

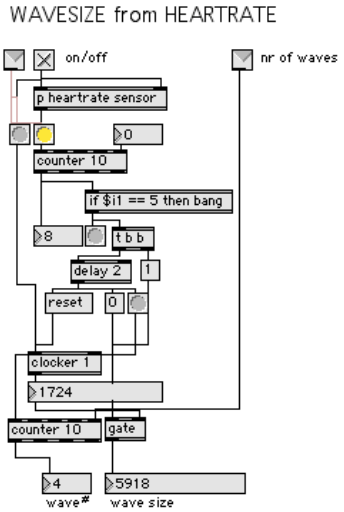

Figure 3: Calculating wave size in milliseconds according to heart rate.

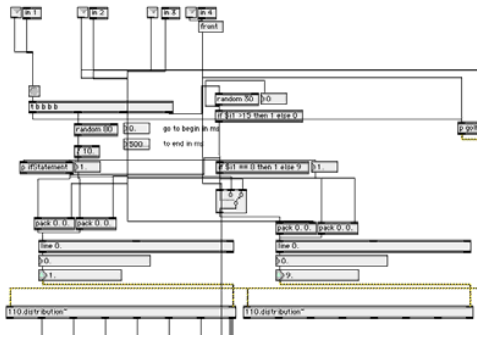

Figure 4: Spatial position of wave.

5. Action-reaction cycle.

In order to get a meaningful interaction, a feedback loop was installed, based on an action-reaction cycle model for ecological interaction (Leman, 2007)[vii]. The cycle consists out of 4 stages, called: Play, Listen, Judge and Change. *Play* is the stage in which sound is generated. *Listen* involves the perception of sound, while *Judge* involves its evaluation. In the final stage the action is *changed* to modify the resulting sound. Within interactive art, both the Judge and Change stages are often left unexplored, resulting either in responsive art intended as responsive art or responsive art intended as interactive art. Both have little to do with what I call meaningful interaction. Within the states Judge and Change lies the essence of meaningful interaction because they rely on the activity of the participant, even if this activity is unconsciously stimulated.

In the case of 'The Heart as an Ocean', the Judge and Change stages are implemented in a rather direct way. Judge is calculated as the relationship between speed and amplitude of previous waves and the heart rate. Change is calculated as the amount of energy the installation will implement in the next wave. To complete the cycle, the installation will first Listen to the heart rate and only then start to Play.

Eventhough the mapping is rather obvious, the results were impressive. People interacting with the installation all made similar comments. The participants found the interacting to have a soothing effect. Most of the participants identified with the sound. They liked to listen to themselves. Some of them fantasized what kind of beach (either sandy or rocky etc.) they were on through analysing the sound. Most of them wanted to walk in the exhibition space instead of sitting down, what has led me to change the sensor into a wireless sensor for future exhibitions.

6. Problems to solve / Problems solved.

Concerning the installation, some changes have further improved the basis for interacting. Originally, the heart rate sensor used a three point measuring technique with the consequence that the public had to sit down in front of the installation. In addition, there was also a lot of noise in the sensor data that had to be filtered out. More accurate commercial heart rate sensors were at that time too expensive or too hard to implement. As a result, not every heartbeat came across and sometimes, although largely filtered out, noise was interpreted as a heartbeat. By using new commercial wireless heart rate sensors, these problems have now been fixed. Although a speaker setup spanning eight meter is enough to have a distinct spatial impression, a lot of extra reverb effects were added to ameliorate the experience. Having a bigger exhibition space with more speakers and more generated waves is preferred.

7. Discussion

The reaction of the public corresponded with the intended design of this project. And after some time, depending on the subjects, the effects of the installation on the public's physiology were quite similar. This leads to some points of interest in extending our research of interactive art. First of all, there is indeed the need to further (re)define interaction within interactive arts. The idea that the installation needs to mediate intelligently between the artist's concept and what the public conceives is of great importance. Secondly, if you choose to implement interactivity, it should be a necessity from the point of view of the affordance of the installation, which engages the user in an interaction that is originally intended, rather than in an interaction about the technological mediator. Finally, it can be stated that interactive and responsive art are essentially different from each other. The main difference is that interactive art subscribes an action-reaction cycle model in which feedback has an effect on the conditions for interaction.

References.

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